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AUTHOR Lehtonen, Jaakko; Sajavaara, Kari
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ABSTRACT

A study used two auditory tests of reaction time to compare second language learners' and native speakers' detection of ambiguity or acceptability of sentences. The subjects were Finnish learners of English as a second language and native English-speakers. The investigation found that Finnish-speakers' reactions were generally similar to the native speakers' with the exception of the time taken to make judgments. The native speakers appeared to have immediate access to meaning through context, while the nonnative speakers may have had to resort to problem-solving strategies, taking significantly more time. There were also clear differences between individual Finnish subjects, reflecting English proficiency. Sentences using material learned either early or late in the language learning process required more processing time than those using material learned in between, suggesting that the hierarchy of learning difficulty cannot be equated with the hierarchy of processing difficulty. Native speakers were generally more unanimous in their decisions. For sentences ambiguous to natives, the Finnish subjects could see only one possible interpretation, the more basic or common one. However, it is noted that the apparent simplicity of these findings does not necessarily reflect responses in real-life interactional situations. Tables and figures are included. (MSE)

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ACCEPTABILITY AND AMBIGUITY IN NATIVE AND SECOND LANGUAGE MESSAGE PROCESSING

Jaakko Lehtonen
Kari Sajavaara

University of Jyvaskyla

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Jaakko Lehtonen and Kari Sajavaara
University of Jyväskylä

ACCEPTABILITY AND AMBIGUITY IN NATIVE AND SECOND LANGUAGE MESSAGE PROCESSING

Introduction

The evaluation and testing of the cognitive processes related to the use of second and foreign languages are possible only if we know what is the nature of the knowledge which is in operation during the processes of fluent native language production and perception. Unfortunately, very little is known of such cognitive processes; existing theories and hypotheses are often contradictory, and they typically represent only a partial explanation of the entire processes of language production and language reception. Therefore, any discussion of these phenomena today is to be regarded as a preliminary and rather subjective synthesis of some of the phenomena involved offering a tentative explanation for the foreign language processing problems.

Such has also been the theoretical startingpoint for a series of psycholinguistic experiments and tests carried out within the Jyväskylä Finnish-English Cross-Language Project. The claims made in this context are highly hypothetical, and all of them have not yet been experimentally verified. It also goes without saying that all the views of the present writers on the topic cannot be discussed in detail here. Some of the views will be only very superficially touched upon; some may even be based on misunderstanding, and some may have been distorted when transferred from their original framework to a context which is no longer coherent with the original theory.

Contrastive psycholinguistics does not only aim at a parallel description of the processing modes of the speakers of the two languages; it is perhaps even more important to study the interaction of various processing modes in the linguistic processing by a foreign language student as compared to those of the native speaker. Knowledge of the actual ways of processing has important implications for the theories about foreign language learning and teaching.

A look at recent models and theories of reading and speech perception implies the existence of a model in which speech perception is described in terms of a complex interaction between bottom-up, input-driven processes and top-down, knowledge-driven ones, ie. analytical and mnemonic processes (see eg. Cole and Jakimik 1980, Grosjean 1980, Marslen-Wilson and Tyler 1981). What is perceived as a result of these processes can be described as a joint function of what is seen and/or heard and what is known and believed. This notion serves as a startingpoint for the present psycholinguistic analysis. The foreign language student cannot be helped in his foreign language processing difficulties before it is found out (1) what the student knows, (2) what he hears, and (3) how he applies these two sources of information in language processing, ie. what he attempts to hear. An important parameter of the phenomena involved is the fact that the processes of language production and language reception take place in real time, which necessarily involves certain serial and consecutive procedures. One of the questions that remain open to date is that of the relative order of various events of recognition and interpretation. There are certain indications of the fact, moreover, that "the processing patterns observed reflect not the operation of specialized language processes, but rather the operation of more general perceptual and cognitive strategies" (Grosjean and Lane 1981:207). This implies that too strict an adherence to linguistic processes alone may prove out to be destructive for the purposes of the study of psycholinguistic processing.

The reaction time test

As is quite well known (see, eg., Sajavaara and Lehtonen1980), one of the greatest problems in cross-language communication analysis is the planning of the experimentation necessary for the study of the relevant processes and strategies. We lack the means to interfere in the processes in a way which would be powerful enough to bring up parameters effective at various processing stages in the cross-language communication speech channel.

The Finnish-English Cross-Language Project has made an attempt to apply certain methodologies used in psychology and psycholinguistics to the study of a bilingual speaker's speech behaviour in his mother tongue and his second

language as contrasted to that of a native speaker of the second language concerned. These experimental methodologies have been used to supplement the data which has been gathered by means of more traditional techniques used in applied studies. However, it is to be admitted that these methodologies offer a means to give certain highly tentative explanations, and the major problem still exists of how to approach the analysis of processes.

The methods with which the project has experimented are various applications of the shadowing technique, reaction time tests, tests with distorted speech stimuli, and the gating paradigm (cf. Grosjean 1980). For this paper, only some of the results of the reaction time applications have been available. In current psycholinguistics, reaction time measurements are no longer an exotic research tool; today they may be more in evidence than ever, since they have proved to be valuable in isolating mental subsystems and various psychological 'pathways' (cf. Lachman et al. 1979:181ff.). The interpretation of the data in the present paper in the light of the model of message processing developed in Jyväskylä (see Figure 3 and Sajavaara and Lehtonen 1980) will be partial and, as is obvious, highly tentative (for more details of data and a more extensive analysis, see Havia 1982).

The application of reaction time testing methodology in a contrastive framework is based on the simple hypothesis that the foreign language student needs more time for all kinds of processing when using the foreign language than the native speaker does, and the difference in processing time is expected to be reflected in the time latencies found in the error detection tasks of the experiment reported here.

Tables 1 and 2 summarize the results of two of the tests carried out in this context. The tests were called the Simple Auditory Test (SAT) and the Auditory Monitoring Test (AMT). The tests were primarily concerned with different uses of the English article. The Simple Auditory Test was administered to twenty Finnish learners of English and to eight native speakers; ten of the Finns and four of the natives were then subjected to the Auditory Monitoring Test.

In the Simple Auditory Test the subjects were presented 22 sentences (see Table 1). Fifteen of the sentences involve different instances of English article usage divided in three categories (the generic uses of the article, the specific definite article before nouns specified by a modifier, and the specific indefinite article); seven of the sentences are to be considered grammatically

Table 1. The acceptability judgements by the native and non-native speakers and the native and non-native reaction times for the sentences in the Simple Auditory Test ($\bar{x}$ = the mean of the reaction times in msec, s = the standard deviation of the RTs in msec; the statistical significance of the differences between the means of the two subject groups is indicated as follows: +++ = very significant, $p < .001$, ++ = significant, $p < .01$, and + = almost significant, $p < .05$). From Havia 1982:63.

I LEARNERS (N=20)				II NATIVE SPEAKERS (N=8)				significance of the difference between I & II	Sentence no.
judgments		RTs (msec)		judgments		RTs (msec)			
yes	no	$\bar{x}$	s	yes	no	$\bar{x}$	s		
17	3	1595	1003	7	1	1166	224		1. I find modern Finnish design very exciting.
17	3	1846	701	5	3	1629	914		2. Ann has less friends than Jane.
12	8	2748	1148	1	7	1916	705	+	3. Beer we drank yesterday was sour.
17	3	1759	897	8	-	642	367	++	4. There was a rope lying on the ground.
19	1	1460	795	8	-	833	458	+	5. The relationship between them had come to an end.
10	10	2508	814	2	6	2253	1145		6. There's the new boy in our class.
16	4	1241	904	8	-	670	403		7. Jeff has finally given up smoking.
8	12	2318	984	2	6	1615	755		8. I would certainly help you if I would have more money
5	15	2405	1023	-	8	1710	713	+	9. A tiger is numerous in these parts.
12	8	1875	732	-	8	1168	691	+	10. Records on the table are mine.
20	-	1473	956	8	-	870	600		11. The eagle is rapidly disappearing from this continent.
6	14	2364	793	1	7	1493	549	++	12. We had to wait a long time to the train.
11	9	2890	785	3	5	2070	898	+	13. The luck has always been on his side.
16	4	1743	1040	8	-	597	243	++	14. I gave John a book for his birthday.
3	17	2403	779	-	8	924	318	+++	15. John's money were all gone.
15	4	2907	1619	6	1	1856	1464		16. The Australian is often tall.
14	6	2387	1229	5	1	1807	726		17. I saw very good film last night.
12	8	1906	900	-	8	917	713	++	18. Nothing is known about fate of the party.
13	7	1968	1307	8	-	1145	716		19. There's the new boy in our class.
19	1	1839	1132	8	-	762	353	++	20. The fear he felt was something quite new.
6	14	2760	1014	-	8	1769	700	++	21. I have seen never anything like that before.
5	15	2805	1184	-	7	1565	789	++	22. Now John dates the prettier girl than Sue.

unacceptable. In addition, there are seven sentences which serve as distractors to divert the subjects' attention from problems of article usage. The test sentences were presented to the subjects in a random order, and the subjects were asked to push a *no* button as soon as they had decided that the sentence was unacceptable, or a *yes* button if they decided that it was acceptable. The purpose of the test was twofold: (1) to give information about the subjects' judgements on the acceptability of the sentences, and (2) to give information of the time that it took for the subjects to make their decisions. The subjects were also asked for the reason why they judged the sentences unacceptable whenever they did so.

The Auditory Monitoring Test consisted of 12 test sentences, which all involved instances of article usage divided in the three groups mentioned above. Four of the sentences represented each one of the three groups, two being acceptable, two unacceptable. The subjects of this test were told before the test that the test sentences might contain instances of unacceptable article usage; otherwise the administration of the test did not differ from that of the Simple Auditory Test.

Figures 1 and 2 represent the results of the two reaction time tests. In the figures, the test sentences are arranged in the order of the Finnish subjests' reaction time lengths, and the earliest time at which the possible error in the sentence could potentially be detected hypothetically has been marked by means of an arrow.

The length of the sentences did not have a marked effect on the reactions. In the SAT, the correlation between the reaction times and the lengths of the sentences was -.05 for the Finnish subjects and -.09 for the native speakers, and in the AMT, the corresponding coefficients were .49 and -.26. The only positive correlation, that of the Finns for the AMT, can be explained as being due to the fact that a great number of the reaction times deviated markedly from the means.

The interrelationship between the length of the sentences and the hypothetical error detection point may also be of certain relevance for the assessment of the reaction time data. It could be predicted that – remembering that there is a certain latency for all reactions – the earlier the hypothetical detection point is the closer to the end of the sentence also the actual reaction to the sentence cue. This assumption is based on the hypothesis that the interpretation of the sentence proceeds, at least in part, lineally with the

Table 2. The acceptability judgements by the native and non-native speakers and the native and non-native reaction times for the sentences in the Auditory Monitoring Test ($\bar{x}$ = the mean of the reaction times in msec, s = the standard deviation of the RTs in msec; the statistical significance of the differences between the means of the two subject groups is indicated as follows: +++ = very significant, $p<.001$, ++ = significant, $p<.01$, and + = almost significant, $p<.05$). From Havia 1982:75.

I LEARNERS (N=10)				II NATIVE SPEAKERS (N=4)				significance of the difference between I & II	Sentence no.
judgments		RTs (msec)		judgments		RTs (msec)			
yes	no	$\bar{x}$	s	yes	no	$\bar{x}$	s		
1	9	1016	583	2	2	1556	1511		1. My favourite drink is the wine.
8	2	1468	839	4	-	916	723		2. He is studying the history of English.
10	-	1054	776	4	-	488	219		3. The books Jim gave me were interesting.
1	9	2497	1489	2	2	2081	1815		4. There was the accident in the street.
5	5	3336	1186	-	4	2090	665	+	5. A lion is found widely in many parts of Africa.
10	-	1584	600	4	-	578	283	++	6. Music is Tom's latest hobby.
1	9	1588	856	-	4	933	504		7. John has just read very interesting book.
1	9	3028	1103	1	3	2884	1442		8. Death of her friend came as a great shock.
9	1	1957	876	4	-	595	364	++	9. The aeroplane has made travelling a lot faster.
10	-	1512	392	4	-	676	335	++	10. Tom bought his wife a new hat.
1	9	1929	610	-	4	1350	818		11. Ink you gave me was red.
9	1	1887	657	4	-	614	291	++	12. There is a table over in the corner.

speech input. Therefore, the correlations were calculated between the reaction times and the sentence lengths minus the part of the sentence that figured before the predicted decision point. In the SAT, the correlations were r = -.18 for the Finns and r = -.21 for the native speaker, and in the AMT, r = .3 and r = .38 respectively.

The weak positive result of the AMT may be seen as an indication of the fact that the expectations as concerns the type of problem to be encountered in the sentences to be processed lengthen the reaction times as calculated from the ends of the sentences. These expectations make part of the information available in the data store for the top-down processing mode, and it seems that the time needed for this type of search is increased as a result of this information alone. Hypothetically, it could actually be expected that the result should be the other way round because the subjects were aware of the type of problem that was to be expected.

Native vs. non-native reactions

For the most part, the reactions of the Finnish subjects were similar to those of the native speakers, although there were some notable exceptions. The native speakers made judgements more quickly, and in the AMT the reaction times were clearly shorter than in the SAT. It seems that in their reactions the native speakers generally relied on automatic decisions and the amount of monitoring was low, while the Finnish subjects may not have developed similar operational schemata and had to resort to conscious problem-solving strategies. The native speakers responded 810 milliseconds faster on an average in the SAT and 675 milliseconds faster in the AMT. The difference of the means between the two groups is not, however, statistically significant in all of the instances.

The difference between the means of the native and non-native responses was statistically very significant ($p < .001$) for one sentence only. It was sentence 15 in the SAT (* *John's money were all gone*). As many as 17 out of the 20 Finnish subjects found the sentence to be unacceptable (and for the right reason), but it seems that this decision required a great deal of monitoring, which lengthened the reaction times (the reaction times were 2403 msec for the students but 924 msec for the natives). In the SAT there were seven

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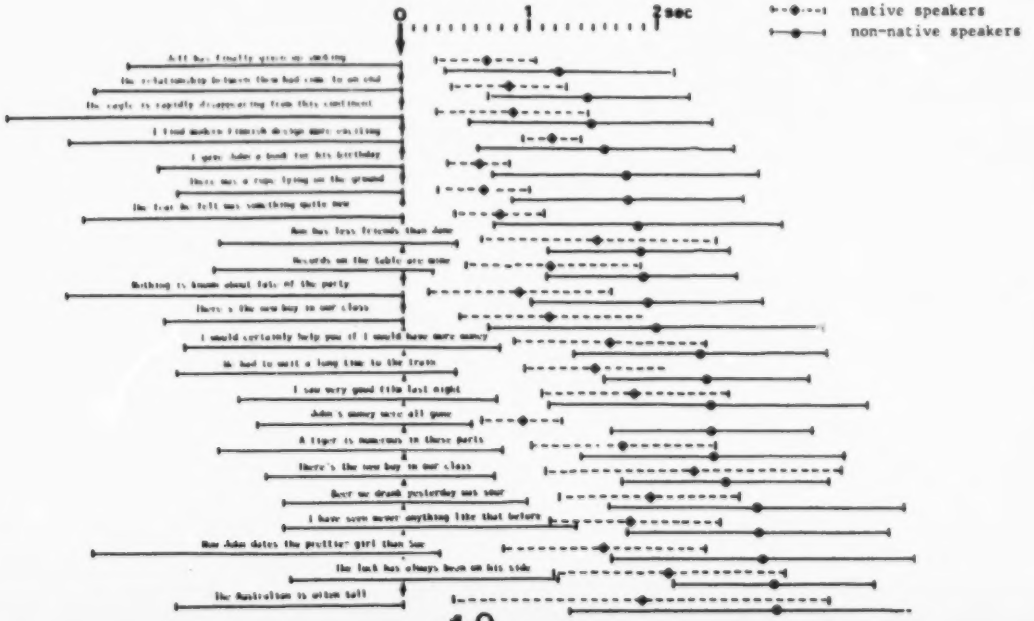
Fig. 1. The test sentences of the Simple Auditory Test (SAT) arranged in terms of the durations of the Finnish subjects' reaction times (RT). The lines under each sentence stand for the actual duration of the sentences. The predicted acceptability decision points are indicated by means of arrows within the sentences or at the end of them. The means and standard deviations of the natives are indicated by means of square dots and dotted lines, and those of the Finnish students by means of round dots and continuous lines.



sentences, and in the AMT four sentences, for which the difference between the means of the reaction times of the two groups was significant at the .01 level. A reaction time that may be two to three times longer than that of the native speakers does not mean that the non-native speakers arrive at mixed results in judging the acceptability of the sentences. For instance, sentences 4, 14, and 20 of the SAT were judged almost unanimously acceptable after reaction times which were three times longer than those of the natives.

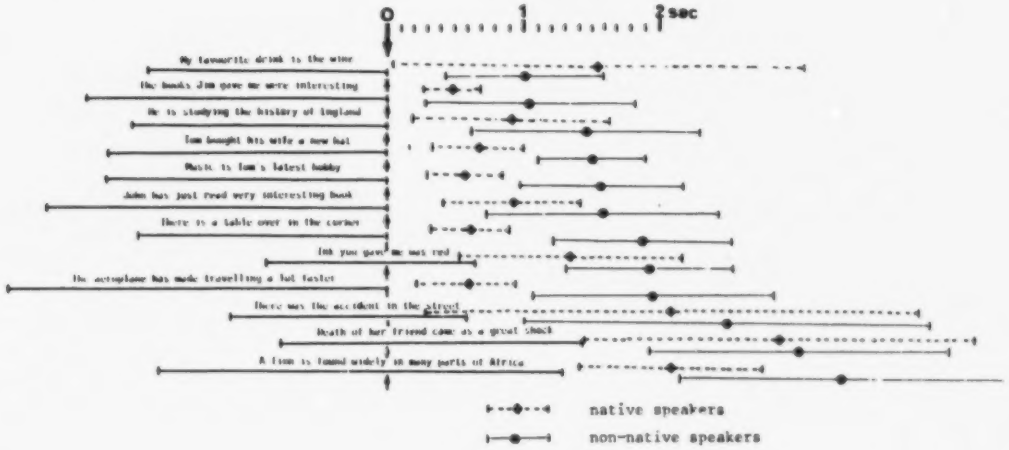
There were clear differences between individual Finnish subjects, which can at least partly be interpreted as being due to differences in the subjects' English language proficiency (cf. Vellutino's distinction between skilled and less skilled readers, see Vellutino 1982:79). More proficient students responded to the test sentences faster because they had more automatized, implicit knowledge about the language. Yet Havia (1982) was able to point out that reaction time tests are no reliable test of language proficiency, which seems to indicate that some part of the variation in the non-native reaction has to be explained on the basis of individual differences in the use of the monitoring mode. There were also instances of the Finnish subjects not being able to make anything out of the sentences included in the test.

In some earlier studies concerned with the use of the English by Finnish students of English, a hierarchy of difficulty has been established on the basis of errors made by the students (Herranen 1978). In a way, such a hierarchy could also be seen to represent learning difficulty. The reaction time tests reported here seem to indicate that a hierarchy of difficulty based on error analysis does not correlate with processing difficulty as reflected in the present tests.

For the present tests Herranen's hierarchy was divided into three categories (for further details see Havia 1982): easy, medium and difficult. If errors in the use of the articles also reflected difficulties in the processing of articles, the reaction times should be longer for items that can be specified as difficult.

In the reaction time tests, the 'medium' sentences had the shortest reaction times, while the 'easy' and 'difficult' were more or less equal and had longer reaction times. The present material is not extensive enough to make any far-reaching conclusions possible, but it seems that there is no significant difference between the three categories as to the extent to which they burden the listener's processing capacity. This also means that learning difficulty and

Fig. 2. The test sentences of the Auditory Monitoring Test (AMT) arranged in terms of the durations of the Finnish subjects' reaction times (RT). For the explanation of the symbols see Figure 1.



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processing difficulty cannot be equated. The hierarchy of difficulty as established on the basis of error analysis was not operative in the processing of the test sentences. Items learned early, ie. 'easy', and items learned late, ie. 'difficult', may involve processing capacity to an equal degree.

The results of the tests indicate, first of all, that there is a great deal of variation even in the native speaker judgements, which is to be expected on the basis of what is known about the research concerned with lexical access (see, eg., Vellutino 1982:177). In some cases, the differences in native speaker judgements can be explained as being due to mishearing or various types of slips, or to a process similar to that found in word recognition tests with items with missing elements (cf. Vellutino 1982:40ff.) – here only at the syntactic level – in that the listener tends to patch up defective strings with elements that have been missing with regard to the hearer's idea of the probable interpretation of the sentence (eg., sentences 3, 12, and 17 of the SAT). The hearer obviously expects the sentences he hears to be correct, as is normally the case in natural communicative interaction. In some cases, the natives obviously reacted to the test sentences under the influence of their experience with teaching Finnish learners of English (eg., sentence 2 in the SAT). Some of the differences between the native speakers clearly indicate that even some of the native speakers monitored their reactions, ie. they did not entirely rely on their native speaker 'intuitions'.

As a whole, the native speakers were much more unanimous in their decisions than the Finnish subjects. For the most part, when they disagreed in their judgements, the sentences were ambiguous, mainly in the sense that it was rather difficult to establish a potential context for them. The judgements of the Finnish subjects on the ambiguous sentences did not show much variation, whereas they disagreed strongly on sentences which, according to native speaker judgement, were clearly unacceptable (eg. sentences 3, 10, and 18 of the SAT).

It seems that for the sentences ambiguous to the natives the Finnish subjects were able to see one of the possible interpretations only, ie. the one which is more common or which relates to some 'basic' rule of English (school) grammar. A typical example is the reactions to the 'exceptional' existential sentences found in the test:

SAT 6 There's the new boy in our class.
AMT 4 There was the accident in the street.

as against the 'normal' existential sentences such as:

SAT 4 There was a rope lying on the ground.
AMT 12 There is a table over in the corner.

For SAT 6 and AMT 4, the means of the native speaker reaction times were slightly shorter than those of the Finns, but the standard deviations were significantly greater (SAT 6, s = 897 msec for the Finns and 1145 msec for the natives, and AMT 4, s = 1489 msec for the Finns and 1815 msec for the natives). For SAT 4 and AMT 12, the standard deviations do not differ from what can be considered normal for the natives in the present test. The result clearly reflects some deficiencies in the Finns' ability to figure out possible contexts for the 'exceptional' existential sentences: they were less able to imagine possible 'worlds' in which the sentences could be located, while the greater standard deviations for the natives indicate that some of the natives, at least, spent a longer time in searching for such contexts on the basis of their wider pragmatic knowledge of the uses of their native tongue.

The process of sentence perception

In normal interactional situations, the interactants find themselves in a state of uncertainty. Their task as participants in communicative interaction is to reach an agreement on each other's intentions. The interactants start from a number of facts that are known to them on the basis of various parameters of the situation (relating to the context and the interactants themselves); this knowledge functions as a primary set of constraints for the possible interpretations of the interactant's messages. The identification and further interpretation of the incoming messages is crucially dependent on these constraints, and takes place, for the most part, through a process of rejecting the improbable interpretational variants offered by the message processor.

The rejection of a potential interpretation takes place on the basis of any knowledge available for the processor, either syntactic, semantic, pragmatic, or other. This process of rejecting the potential interpretations may lead to a situation of ambiguity: the processing mechanism is unable to judge which one of the several possible interpretations is the one which is to be left behind after the rejection process.

In tests of the present type, the hearer is seriously handicapped – as against hearers in naturalistic situations – by the fact that he lacks the context which normally figures on the left-hand side of the sentence. It can be predicted that in situations like this some native speakers spend more time imagining possible contexts while others may have access to several potential interpretations from the very beginning, which makes it possible for them to solve the interpretation task in a time clearly shorter than the average (cf. Pynte 1978:126). This is seen as an increase in the standard deviations of the native speaker reaction times. In addition, it is also possible that the hearer is left with no possible interpretation despite the fact that there is no abvious reason for rejecting the sentence.

In interactional situations, the speech input from the other party is an unknown denominator positing certain open questions in addition to the elements that are predictable on the basis of the constraints mentioned above. The interpretation process could be described as consisting of attempts to decrease the amount of uncertainty. In most cases, the hearer is satisfied with a state which leaves the level of uncertainty unaltered or lower than before as a result of the input received. If the interpretation based on the speech input results in a rise in the state of uncertainty, ie. the score of potential errors as detected by the hearer rises higher than is accepted by him, the hearer takes steps to interfere in the process (cf. Marcus 1981:199).

Theoretically, the hearer can resort to two ways when he wants to interfere: (1) he can ask for more input, ie. he interferes in the speech chain of his interlocutor and asks for more information (which is something that is not possible in test situations of the present type), or (2) he scans his memory for more information that could be used for the interpretation of the message. People scan their memories at the rate of about 38 milliseconds per item, which means about 25 items per second (Lachman et al. 1979: 131). The more information there is at hand the longer the processing time. This kind of reasoning means for the analysis of the tests of the present type that the natives

would always be slower in their reactions because of the greater amount of linguistic and other knowledge that they process. This is not however the case, as is seen in the test results even for the ambiguous sentences: the means of the native speaker reaction times are lower with the exception of one single sentence, which is sentence 1 of the AMT, *My favourite drink is the wine.*

The conclusion to be drawn from the results is that the natives have more automatized knowledge of the language to be used to facilitate the preattentive, automatic process of recognition. The fact that *some* native speakers spend a longer time than the non-natives in seeking the information to be used for interpretation is reflected in the standard deviations. The non-natives having less experience with the language have normally to rely on the immediate, often linguistic, context. Simultaneously they are less able than the natives to make use of the context for their interpretations. This means that they have to rely on their first-hand reactions which are mostly based on a bias reflecting various teaching-induced criteria concerning acceptable usage. The non-natives have fewer garden paths to be tested (cf. Grosjean 1980) than the natives, which also means that they have fewer probabilities to be considered.

Reactions to ambiguity

As was pointed out above, the Finns' reactions to the ambiguous sentences did not show much variation. For instance, the Finns' reactions to sentence 1 in the AMT were the fastest for all twelve test sentences through an almost unanimous non-acceptance of the sentence, while only three of the sentences required longer mean reaction times for the native speakers in this test, the four natives reaching a tie in their decision as to the acceptability of the sentence. It seems that the search for a possible interpretation is particularly tricky in this instance because it requires the glossing of a countable use for the word *wine*, which seems to be rather improbable in this particular context ('My favourite drink is that particular brand of wine.').

One of the three sentences that required longer reaction times of the natives is one of the 'exceptional' existential sentences, sentence 4, *There was the accident in the street*, which, typically, would require the left-side con-

text, as is seen in the 50% rejection of this sentence as unacceptable by the natives.

For sentence 5, *A lion is found widely in many parts of Africa*, the native speakers were unanimous in their negative reaction, while this sentence was very problematic for the Finns. Those of the Finns who could not rely on their automatic reactions, ie. whose proficiency in English was not good enough for them to be able to make the decision automatically, were unable to refer their decision to any rule, because in this case there is no rule available in school grammars. The relatively great standard deviation for the native speakers in this case may be due to the same reason: despite the apparent acceptability of the sentence the indefinite article cannot be used for generic reference in sentences like this.

The third sentence, sentence 8, *Death of her friend came as a great shock*, for which the reaction times of the native speakers were longer than for sentence 1 is clearly grammatically unacceptable despite the fact that one of the four natives was able to think of a context where he could use it; it took a long time for him to come to this conclusion, which also explains the unduly great standard deviation for this sentence despite the fact that this sentence is not ambiguous the same way the above sentences are. The Finnish subjects were largely dependent on their explicit grammatical knowledge; they seem to have scanned their memories for rules irrespective of the test type. Even in the Simple Auditory Test they clearly monitored, although the test was designed to call forth automatic processes.

Implicit knowledge seems to be used more readily for sentences which are clearly acceptable or clearly non-acceptable, while in cases of trouble the monitoring facilities are immediately available. This speaks in favour of a processing model in which the information available through the input is accessed in two modes: a direct mode, in which the hearer makes use any information available to identify and interpret the signal as soon as possible, and an indirect analytic mode, which is necessary whenever the direct mode fails to give a satisfactory response. In most cases, the recognition threshold is reached directly, and the budding analysis fades away (cf. Lehtonen and Sajavaara 1980).

It is necessary for the speakers to "utilize familiar patterns to reduce the amount of input information that must be processed to effect identification" but, simultaneously, familiar patterns are used to "aid in identifying new and less familiar strings" (Vellutino 1982:121).

It is easy to conclude on the basis of the preliminary data derived from the first set of reaction time tests included in the Jyväskylä Cross-Language Project in full agreement with Vellutino (1982:34) that "word recognition necessitates a variety of strategies that the skilled reader apparently has at his or her disposal". It is important to remember that the "unit of perception is relative rather than absolute". Syntactic knowledge could be given as an example of the multiple uses of input data; it can serve the following four functions: recognition, prediction, enumeration, and postdiction. Syntactic knowledge can enable the listener to recognize familiar patterns; it can enable him to predict a likely concomitant event; it allows for him to enumerate the various realizations of a prediction; and it can enable him to confirm a hypothesis which is consistent with a constraint (cf. Hayes-Roth 1980: 2ff).

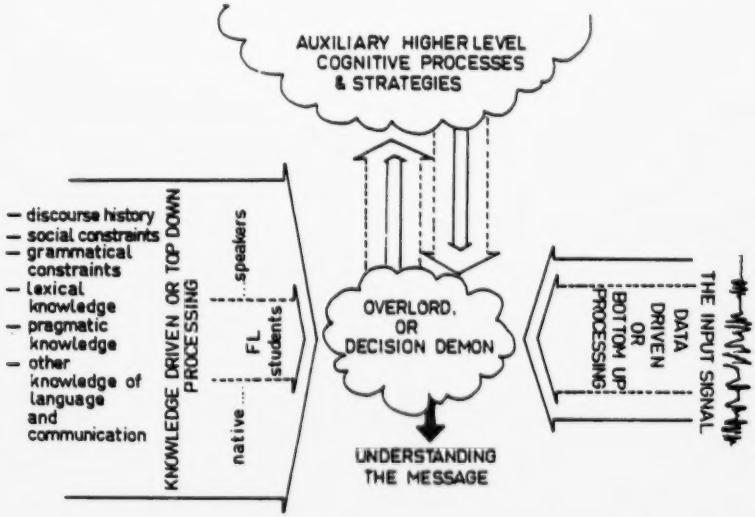
The top-down bottom-up dichotomy

The direction of the information flow in the mind of a foreign language learner as compared to that in the mind of a native speaker is one of the interesting problems involved (see Figure 3). In normal fluent native-like processing, much of what is 'understood' seems to be based on the existing knowledge of language and language use, while cognitive monitoring of the speech input is often thought to be active rather rarely when, for instance, uncommon words or very complex or otherwise difficult sentences occur.

The process of understanding is relatively fast as compared to the progression of the speech input on the time-axis. Automatization of many of the processes leaves cognitive capacity for, eg., discourse regulation and textual processing and other cognitive processes which take place during communicative interaction.

In many cases, the foreign-language student seems to be unable to use what is called the top-down processing mode simply because there is no such knowledge in his memory that could automatically generate predictions for linguistic or other relevant structures, or activate words or idioms in the lexicon by means of transitional probabilities and reject improbable interpretations of the speech input, which may be, moreover, reduced and seriously distorted. Accordingly, the non-native speaker gives the impression of being

Fig. 3. A highly simplified graphic illustration of the two modes, top-down and bottom up, of information processing necessary for message understanding. The illustration implies that both the amount of available linguistic and other top-down knowledge and the amount of information which a person is able to pick up from the incoming speech signal or a string of letters is smaller for the foreign language student. Accordingly, he is forced to resort to higher-level cognitive problem-solving strategies more frequently than the native speaker, which, in turn, consumes cognitive capacity, takes time, and results in break-downs and disfluencis in communication. For further details, see Sajavaara and Lehtonen 1980 and Sajavaara 1981.



more dependent, in many cases, on the speech input than his native interlocutor is. A native speaker's larger experience with the language and his better knowledge of the canonized structure of the language makes it possible for him to make use of the reduced and distorted speech signal (cf. Slobin and Bever 1982).

When a non-native speaker does not know a word or does not recognize an idiom, his only chance is to resort to his native language knowledge , to his general knowledge of human behaviour, language and communication and, what is more noteworthy, to the explicit knowledge of the grammatical

structures of the foreign language as taught in the foreign language classroom. The testing of various translation equivalents, monitoring of the rules, and other cognitive problem-solving procedures load the cognitive system to the effect that the student is no longer capable of other kinds of behavioural planning and regulation. This, in its turn, may call forth situational anxiety, which makes communicative tasks even more difficult and, in the utmost case, results in a total collapse of the interactional situation.

Vellutino (1982:79) concludes from his survey of recent research in perceptual units of word recognition in reading that the perceptual unit is determined by "three interacting contingencies": (i) the context in which the word is encountered; (ii) the characteristics of the word itself; and (iii) the skill of the reader. This relates directly to the problem of the relative importance of top-down or knowledge-based and bottom-up or input-driven processes at the early stages of second language acquisition as against the situation when a higher level of language proficiency has been reached. The tests discussed in the present paper, for instance, could be interpreted, at least in part, as an indication of the fact that, in comparison with the native speakers, the Finnish learners seemed to be more dependent on the speech input. For instance, six out of the twenty Finnish subjects were able to report sentence 17 of the SAT (**I saw very good film last night*) as unacceptable, while five out of six natives accepted what they heard.

Top-down processes are normally regarded to be more typical of fluent readers as compared to the beginners, who are thought to be more dependent on clues on the letter level (cf. Tommola 1981:93). More recently it has however been suggested (see, eg., Stanowich 1980:58; cf. also Vellutino 1982: 156-170) that even the youngest readers are able to use context to facilitate word recognition and that good readers might be more sensitive to the context than the beginners but less dependent on it. In addition, there is data that seems to contradict the hypothesis that better readers are less reliant on graphemic information. It seems that "it is the processing of the *good* readers that is primarily data-driven, in that it is the speed of their context-free word recognition that allows capacity to be freed for comprehension processes" (Stanowich 1980:58).

It seems that the relevant importance of top-down and bottom-up processing is a much more complicated question from the acquisitional viewpoint than just a mere cline from reliance on input data to reliance on knowledge.

Consideration of the three contingencies which are mentioned by Vellutino reveals that less experienced users of a language are handicapped in terms of all the three criteria. Even if they were forced to rely on contextual information as a result of defective information about potential surface strings in the input, which would make direct access to the lexicon possible, they are less able to utilize the context because of their lack of pragmatic experience with the use of the language. Both for the experienced and less experienced users of the language, the detection mechanisms are attuned to the reception of the input signals, but since the less experienced speakers of the language cannot rely on prognoses based on various canonical sequences embedded in a native speaker's knowledge store (cf. Slobin and Bever 1982), they have to pay attention, to a greater degree than the more experienced ones, to various lexical and syntactic structures; with proficient users of the language such attention is minimal and they are primarily concerned with meaning (cf. Vellutino 1982:156). On the basis of the information about readers at different stages of the development of the skill it can be predicted that at intermediate stages they "would manifest greater variability in their use of meaning and structural principles of categorization" (Vellutino 1982:156). It may also be that serial processes are primary with less proficient learners as against holistic ones.

The foreign language learner

Cross-language data available through the Finnish-English Cross-Language Project seems to imply, in addition, that speakers of different languages may be prone to utilize structural surface information differently (see Sajavaara and Lehtonen 1980; cf. Marcus 1981:201ff.). Bates et al. (1982) report similar results of a study of functional constraints on sentence processing in English and Italian.

In Finnish, lexical surface items contain a multitude of morpho-syntactic information which is valuable for the establishment of the constraint networks that govern the prognostic patterning of the incoming input signal. In English, it is the relative order of the lexical items and their position in the surface string that gives the same information. A speaker of Finnish is thus much more clearly attuned to receive signals that are embedded structurally

in single lexical items. Thus some of the students' difficulties in the processing of English may be caused by interference in such processes or in various schemata in the processing of linguistic information rather than by interference deriving from the grammatical structures of the two languages as such. The amount of such interference depends on the degree of difference in the information-conveying structures between the two languages.

The learner's tendency to rely on structural properties is reinforced by what might be called instructional bias. While native speakers have encoded multiple representations of the information contained in the input strings, the learners tend to focus on certain types of surface phenomena that have been put into relief by foreign language teaching materials. This means that they are able to monitor certain types of phenomena but unable to detect others that do not figure as rules or representations in the teaching materials. Moreover, traditional foreign language teaching practices, at least in Finland, tend to increase, even today, the importance of error-monitoring and error-detection, which is reflected on the reaction times in the present tests.

Some of the students' processes which differ from the processing modes employed by target-language native speakers can be interpreted as being largely dependent on auxiliary problem-solving strategies, to which the students resort to fill gaps in their target-language knowledge. The amount of such 'interference' is inversely proportional to the students' linguistic and pragmatic knowledge of the target language. To a large extent, these strategies consist of various types of interference phenomena, and they include, for instance, the monitoring of the rules learned in the foreign language classroom and the testing of various translation hypotheses based on the mother tongue.

In addition, language users' performance should always be considered to be relative to the task demands. Several task variables can alter the cognitive processes required for the implementation of a linguistic task (cf. Kirby 1982). A situation in which various parameters of perception are studied by presenting isolated test sentences to informants is clearly unnatural: it lacks an important facilitating factor, which is the discourse context (cf. Foss 1982).

In tests in which the subjects are expected to cope with context-free sentences in a rather artificial test situation, native speakers and foreign language learners can be expected to behave differently: the situation can be

expected to affect the natural reactions of the non-natives more than those of the natives. The natives' reactions to the ambiguous sentences in the test as against all the other sentences implies, as compared to those of the Finnish subjects, that even in this kind of a test, the primary concern of the native is meaning, while the Finns tend to be interested in the structural properties. In this way it is essential to consider the interaction between sentence comprehension proper and the tasks which are devised to measure this process, to see whether the procedure guarantees that the subjects make an attempt to understand the test sentences.

The variability of test performance by subjects also causes certain problems. Differently from what was earlier thought to be the case – that learners perform better under conditions in which they tend to monitor – Tarone (1982) has suggested that monitoring causes more variance in the results and accordingly there is a certain tendency for a greater incidence of non-acceptable language usage.

Conclusion

In the 'normal' mode of speech recognition and interpretation, ie. understanding, the access to meaning is automatic, and it proceeds autonomously without the listener being conscious of the processes which are going on. According to the model of ambiguity resolution developed by Seidenberg et al. (1982), when there is ambiguity, the components of meaning are "at similar activation levels"; they are both accessed and passed on to a subsequent integration stage, where they are evaluated against the information provided by the context (Seidenberg et al. 1982:525). In a normal speech situation, contextual information is used in a top-down or message-level processing mode to restrict the number of possible interpretations.

It is possible to hypothesize that processing proceeds independently at several 'levels' simultaneously with the decision reached at each individual decision point being controlled by the various interacting levels in terms of the relevant, precise task conditions (cf. Forster 1979:32; see also Spoehr 1981). One of these levels could be one of acceptability, which involves decisions on the acceptability and non-acceptability of utterances. We could hypothetize the existence of an acceptability-detection automaton, which

automatically weighs the 'familiarity value' of the incoming sentence. If the familiarity falls below the rejection threshold value, or if the sentence deviates too much from what is plausible (cf. Lachman et al. 1979:174ff.), it is rejected and the analysis will not proceed further.

Automatic processing frees cognitive capacity for 'higher level' tasks such as integration of information and inferencing. The processing itself comprises a chain of choices between a limited number of alternatives which are 'primed' by the lexical, semantic, syntactic and pragmatic constraints arising from the context.

In the case of isolated ambiguous sentences such as those included in the tests reported above, the automatic process opens several garden paths, whose appropriateness has to be determined by means of general linguistic and other knowledge with the help of existing cognitive problem-solving modalities (cf. Eisenberg and Becker 1982).

The theory of grammatical decision-making can be integrated into the general model of signal detection, which explains the slower responses found in the tests on the basis of the concept of stimulus familiarity. According to this concept, items that fall below the threshold of unfamiliarity or above the threshold of familiarity are responded to very quickly, because they require no search of memory. But items which fall between the two thresholds are responded to only after a relatively time-consuming memory search (cf. Lachman et al. 1979:173ff.). In the tests reported above, the sentences which fall unanimously below the level of acceptability or plausibility, and are therefore rejected, and the sentences which correspond to the general patterns of expectations, and are accordingly accepted, elicit a markedly faster reaction than those that fall between these two thresholds.

It is necessary to examine further the question of the time needed for decision-making in linguistic tasks where the stimulus is ambiguous in different ways, ie. lexically, syntactically, semantically, discoursally, or pragmatically.

Measurement of on-line processing in terms of the assessment of subject performance such as it occurs in real time is an essential requisite for the understanding of language comprehension. The study of comprehension as a function of time is particularly important in contrastive psycholinguistics because it serves as a method to depict such difficulties encountered by the language learner in foreign language comprehension as are caused by trade-offs taking place as a result of restricted time-by-processing capacity.

We must not, however, be confused by the apparent simplicity and uniformity of some of the test results. It is always important to remember that in tests of this type the complexity of real-life interactional communication is seriously reduced. As is pointed out by Barnes and Todd (1981), conversation "is characterized by ambiguity, misunderstanding, meanings that insensibly change, and by what we have called 'fuzziness', all of which arise from the nature of conversation, the diversity of participants' social experience and therefore the diversity of the frames available". Ambiguity of diverse nature is typical of everyday conversation, which means that native speakers are continuously faced with the kind of dilemmas that are shown to be problematic for them. It goes without saying that such problems are multiplied for a non-native speaker: he may sail through the shallow waters of interactional situations unaware of such problems because, as the tests reported here clearly indicate, he makes his decisions on the basis of defective data and his idea of trouble may be seriously distorted by the apparent simplicity of the processes involved.

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